REMARKS

Claims 1-20 are pending in the application. Favorable reconsideration in light of the remarks which follow is respectfully requested.

The Invention

Before distinguishing the cited art, a brief overview of the invention is in order. The motivation for the invention is to ascertain a chemical process suited for use in a computer-controlled etching system for making precise and small-scale etchings of copper surfaces. The invention is capable of precisely and accurately removing 150 Å or less of material. In contrast, Uozumi and Kondo et al. are much cruder methods for etching surfaces. Uozumi is targeted at achieving etching of approximately 30 nm to 50 nm (col 10, ln 40-42) and is not designed to achieve the accuracy and small-scale of the invention. Kondo is designed for etching on a scale of about 800 nm (col 9, ln 49-51) using mechanical rubbing in addition to chemical means to achieve that large degree of etching. The process of the invention is also designed to achieve a surface smoothness of R_{tm} of 50 Å or less; an achievement that the cruder of methods of Uozumi and Kondo are unlikely to achieve given their removal of 10s or 100s of nanometers of material. The small-scale etching of the invention is achieved by computer monitoring of both the formation of an oxide on a copper surface and its selective removal. In order for a chemical process to be suitable for this application, the chemical process must form a stable passivation oxide layer and provide for the removal of said passivation layer in two separate steps such that each step may be separately monitored.

The Primary Obviousness Rejection

Claims 1-3, 5, 7-11, 14, and 16 have been rejected under 35 U.S.C. § 103(a) over Uozumi (U.S. Patent 6,261,953) in view of Kondo (U.S. Patent 6,596,638). Uozumi relates to forming a copper oxide film on a copper surface using an ammonia-

hydrogen peroxide solution having a pH of 8-10, then removing the copper oxide film with a solution having a weak oxidizing property such as a diluted hydrochloric acid solution. The copper oxide film contains an ammonia complex. Uozumi clearly teaches that the presence of ammonia is important (see Col. 10, line 38).

Kondo relates to a polishing method for metal films involving mechanically rubbing a metal surface with an oxidizer (such as hydrogen peroxide) and a substance which renders oxides water soluble (such as inorganic or organic acids). However, in the Background section, Col. 5, lines 17-31 describes polishing solutions containing either citric acid or aminoacetic acid and hydrogen peroxide. Figure 26 and Figure 9 of Kondo show corrosion rates (etch rates) and passivation rates (formation of copper oxide) of the citric acid-hydrogen peroxide polishing solution and the aminoacetic acid-hydrogen peroxide polishing solution.

The Examiner contends that it would have been obvious to replace the ammonia-hydrogen peroxide solution of Uozumi with the citric acid-hydrogen peroxide polishing solution of Kondo to provide a wider range of stability for etch process, as taught by Figure 26 of Kondo. The Examiner notes that the sharp rise in etch rate versus pH for the ammonia-hydrogen peroxide solution of Uozumi as shown in Figure 6 is not desirable for process control.

The Examiner further contends that it would have been obvious to use an organic acid of Kondo in the second solution of Uozumi because Kondo indicates copper and copper oxide are rendered water soluble thereby.

Applicants respectfully disagree with both contentions made by the Examiner for several reasons. Essentially, there would have been no motivation for one skilled in the art to make the modifications proposed by the Examiner to either the first or second solution of Uozumi.

It would NOT have been obvious to replace the ammonia-hydrogen peroxide solution of Uozumi with the citric acid-hydrogen peroxide polishing solution of Kondo because 1) it would fundamentally change the process of Uozumi, 2) Kondo counsels

using a CORROSIVE solution to achieve high etch rates for removing large amounts of material while the invention has an absolute requirement of a PASSIVATION solution to achieve fine control over the removal of small amounts of material, and 3) Kondo directly TEACHES AGAINST the use of a citric acid-hydrogen peroxide solution for the purposes of forming an insoluble passivation layer.

The basic, fundamental two step process of Uozumi involves forming a copper oxide film that contains an ammonia complex, and then removing the copper oxide film using a dilute acid with a weak oxidizing property. The citric acid-hydrogen peroxide polishing solution of Kondo, as taught by Figure 26, etches copper. That is, the corrosion rate is the rate at which copper is etched. The citric acid-hydrogen peroxide polishing solution of Kondo does NOT generate copper oxide. Generating copper oxide is the passivation rate. Since the citric acid-hydrogen peroxide polishing solution of Kondo would NOT generate a copper oxide film, on which the process of is predicated, substituting the citric acid-hydrogen peroxide polishing solution of Kondo for the ammonia-hydrogen peroxide solution of Uozumi would fundamentally change the process of Uozumi. One skilled in the art would have no motivation to modify the basic two step process of Uozumi when a passivation layer of CuO is required to practice the invention as discussed above. For at lest this reason, the alleged combination fails to establish a *prima facie* case of obviousness.

Second, the fundamental purpose of Kondo is teaching the use of CORROSIVE solutions. This teaching is advantageous to the application of Kondo of etching relatively large amounts of material (about 800 nm) in a short time period as a corrosive solution has a high rate of etching. Such a high rate of etching is not required (50 nm/min) to achieve the fine degree of etching of the invention. In fact, such a high rate of etching would be DELITERIOUS to etching on the angstrom scale.

Third, Figure 9 of Kondo teaches that passivation of copper may only be achieved from approximately pH 7 to pH 12. This directly teaches against the use of an organic acid-peroxide solutions to achieve passivation and an insoluble CuO layer since

such a solution would have a pH less than 7, as the first solution of the invention does. However, the nature of such Pourbaix diagrams change depending on the nature of the system. Specifically, ionic strength, detergents, and presence of certain ions such as ammonium modify the location of boundary lines of the Pourbaix diagram for copper. There is no suggestion in Kondo that a passivation layer may be formed using an acidic solution. Therefore, one skilled in the art could not use Kondo to make an acidic passivation solution as disclosed in Examples 1 to 4 of the invention. Note that the make-up of the preferred embodiments in Examples 1 to 4 are unique in their make-up compared to both Uozumi and Kondo and are intentionally designed to form a passivation layer at acidic pH. This function is claimed in claims 1, 10, and 17. One skilled in the art could not infer the composition of these solutions from the teaching of Uozumi nor Kondo, either separately or combined, as neither suggest how to form a passivating solution at acidic pH.

The Examiner further contends that "it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Uozumi of a two-step process for etching copper by replacing the solutions used in both steps with new solutions provided the new solutions yield better results." As discussed, the citric acid-peroxide solution of Kondo does NOT achieve the same result as the first solution of the invention.

The solution disclosed in Kondo is corrosive and capable of etching copper on its own. The first solution of the invention forms a passivating film and is not capable of etching copper. A solution that does not perform the required function of passivating copper (as the solution in Kondo does not) can hardly be said to "yield a better result." A solution with properties of the first solution of the invention is simply not disclosed anywhere in Kondo nor Uozumi. Further, the computer-controlled process of the invention requires a chemical process where the formation of a passivation layer of CuO can be observed through spectroscopic techniques. The method also requires monitoring of pH, temperature, and other physical parameters. The method is sensitive

enough to stop the passivation process at a point to achieve chemical modification of less than 150 Å of material. The spectroscopic detection relies on the inherently different spectroscopic properties of Cu and CuO, and depth of passivation is determined by measuring the formation of CuO. A process that calls for a corrosive solution that directly etches Cu off the surface would not be able compatible with this computer controlled technique as the direct removal of Cu into solution would not be able to be monitored and would not indicate how the surface has been modified. Therefore, there is no motivation to incorporate any of the methods of Kondo into the current invention.

The examiner contends that the variation in etch rate with pH shown in Fig. 6 of Uozumi provides a motivation to modify the technique of Uozumi with that disclosed in Kundo to achieve greater pH stability. The fine computer control process of the current method makes a prior knowledge of the precise rate of etching IRRELEVANT for process control given the real-time monitoring of the passivation rate. The process also provides for real-time pH monitoring and adjustment which further makes any pH dependence of passivation rate IRRELEVANT. The processes of Kondo and Uozumi are not designed to be used in conjunction with real-time monitoring. Concerns over pH dependence would therefore not motivate one skilled in the art to modify the process of Uozumi.

The purpose of the second solution of Uozumi is to etch or remove a copper oxide film. Since citric acid-hydrogen peroxide polishing solution of Kondo does NOT generate a copper oxide film, substituting the citric acid-hydrogen peroxide polishing solution of Kondo for the ammonia-hydrogen peroxide solution of Uozumi would obviate the use of the second solution of Uozumi. One skilled in the art would not have undermined the purpose of the ammonia-hydrogen peroxide solution of Uozumi (forming a copper oxide film) by using a polishing solution that cannot form a copper oxide film.

For at least these reasons, it would not have been obvious to replace the first solution of Uozumi with the citric acid-hydrogen peroxide polishing solution of Kondo. It is believed that the comments above are sufficient to merit withdrawal of the rejection. Nevertheless, the following comments are also provided.

It would NOT have been obvious to modify the second solution of Uozumi as suggested by the Examiner because the modification would contradict the basic requirements of the second solution of Uozumi.

It would not have been obvious to use an organic acid of Kondo or the acetic acid mentioned in the Background section of Uozumi in the second solution of Uozumi because such a modification contradicts a direct teaching of Uozumi. Uozumi clearly states that the second solution contains a weak oxidizing property. This is because the copper oxide film formed by the first solution is removed with a solution having a weak oxidizing property, such as a diluted hydrochloric acid solution (see Col. 9, line 51). Organic acids, such as those required by the claimed invention, have no oxidizing properties. Acids with oxidizing properties are inorganic or mineral acids. In the context of this technology, inorganic acids and organic acids are not equivalent (that is, inorganic acids and organic acids are not interchangeable). One skilled in the art would readily understand this, and consequently one skilled in the art would not have used an organic acid of Kondo or the acetic acid mentioned in the Background section of Uozumi in the second solution of Uozumi.

Since the acetic acid mentioned in the Background section of Uozumi is clearly known by Uozumi, Uozumi would have mentioned acetic acid as a possible acid with a weak oxidizing property if such were suitable. For the reasons stated in the preceding paragraph, Uozumi made no mention. For these additional reasons, with of the rejection is respectfully requested.

The Remaining Obviousness Rejections

Claim 12 has been rejected under 35 U.S.C. § 103(a) over Uozumi in view of Kondo and further in view of Miller (U.S. Patent 6,719,920). Claim 13 has been rejected under 35 U.S.C. § 103(a) over Uozumi in view of Kondo and further in view of Shimazu (U.S. Patent 6,547,843). Claims 17-20 have been rejected under 35 U.S.C. § 103(a) over Uozumi in view of Kondo and in further view of Singh (U.S. Patent 6,594,024). All of these rejections are based on the combination of Uozumi and Kondo. As discussed in detail above, the combination of Uozumi and Kondo is not sufficient to render any of the claims obvious. The additional cited art of Miller, Shimazu, and Singh fails to cure the deficiencies of the combination of Uozumi and Kondo. Therefore, these rejections should also be withdrawn.

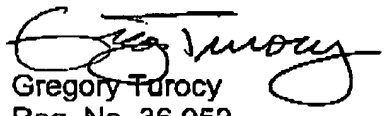
Claims 4, 6, and 15 have been rejected under 35 U.S.C. § 103(a) over Uozumi in view of Kondo and admitted prior art. Since this rejection is based on the combination of Uozumi and Kondo, the combination of Uozumi and Kondo as discussed above is not sufficient to render any of the claims obvious. However, it is further noted that just because surfactants are known, does not mean that ANY novel use of a surfactant is rendered obvious. There must be some teaching or suggestion in the art to employ surfactants in a two act copper removal process. Since there is no teaching or suggestion anywhere in the art of using surfactants in a two act copper removal process as described by the independent claims, claims 4, 6, and 15 are patentable for this additional reason.

Should the Examiner believe that a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

In the event any fees are due in connection with the filing of this document, the Commissioner is authorized to charge those fees to our Deposit Account No. 50-1063.

Respectfully submitted,

AMIN & TUROCY, LLP



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